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ABSTRACT

Applied linguistic theory is examined in light of neuroscientific knowledge, especially in regard to the structure and function of the cerebral cortex, in order to illuminate the process and methods of teaching or learning language. Wernicke's Area and Broca's Area are parts of the brain that have been associated with language function. Topographical representation and functional aspects of these two areas are discussed. The learning of a second language would seem to have in common with the learning of the first language the functioning of Wernicke's Area and Broca's Area. It also seems clear that very different neural pathways and mechanisms are employed by students using different methods of foreign language teaching. Cortical areas thought to be associated with each of the following teaching methods are discussed: audio-lingual pattern drill; empiricist-behaviorist learning theory approach; and an approach in which no emphasis is placed on word-object association. (SW)

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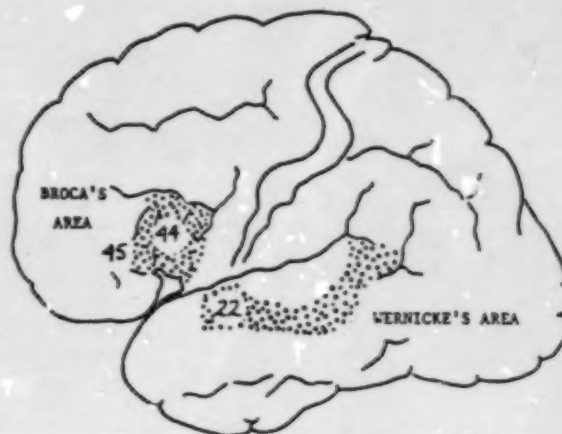
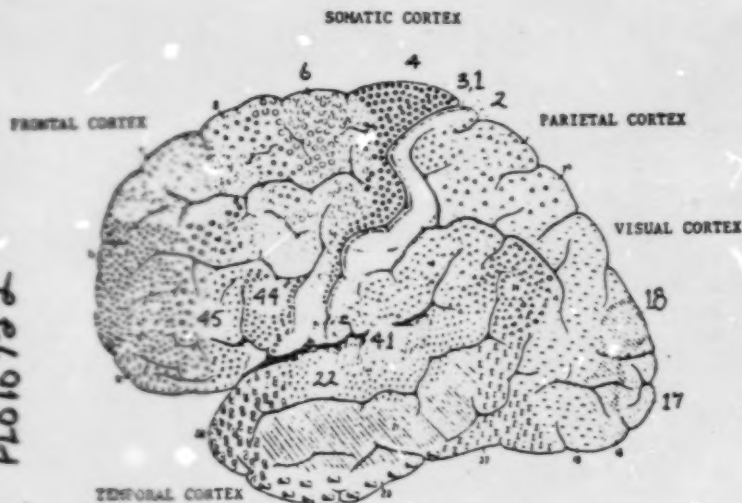
NEUROLINGUISTIC FOUNDATIONS TO METHODS OF TEACHING A SECOND LANGUAGE

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While there has been a certain amount of investigation in the field of language pedagogy on methodology of teaching a second language; and in the neurobiological field in those areas of the brain which are involved developmentally in the acquisition of a first language, and later second language systems, there has been relatively little work attempting to relate these two broad areas.

In the present paper we unify applied linguistic theory to a growing body of neuroscientific knowledge, especially in regard to the structure and function of the cerebral cortex, with the hope that this can help us to learn more about the process and methods of teaching, or learning, language.



1. CYTOARCHITECTURAL MAPS OF HUMAN CEREBRAL CORTEX BY BRODMANN (1914).
TOPOGRAPHICAL REPRESENTATION OF AREAS OF CORTICAL FUNCTION.

As shown in Figure 1, on the left, is a side, or lateral view, of the surface of the human cerebral cortex, and the numerous divisions which have been mapped out by Brodmann (1914) on the basis of different cellular arrangements throughout the depth of the cortex in all areas. The cerebral cortex does not have a uniform structure throughout. The amount of variation that can be seen in different regions of the cortex depends upon morphological criteria, such as layer width, cell types, number and density. There are numerous criteria. Brodmann's numbering of these cytoarchitectural areas has been a convenient reference system for workers in this area of the brain for many years. For example primary visual cortex (Area 17), primary somatic cortex (Areas 4, 6, 3, 1 and 2) and primary auditory cortex (Area 41) are found to be topographically located and distinguishable in all species of placental mammals.

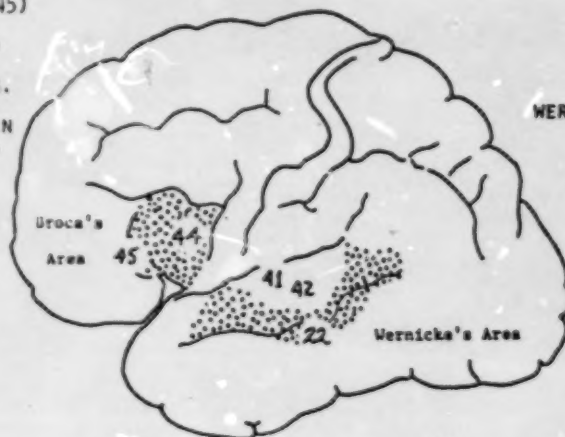
In man especially, two regions have been associated with language function, Wernicke's Area and Broca's Area. For many years a considerable extent of clinical data has established that these two areas play some kind of principal role in language acquisition (Broca, 1861; Wernicke, 1974).

BROCA'S AREA (AREAS 44 + 45)

EXPRESSIVE (MOTOR) REGION RELATED TO SPEECH AND WRITING.

DAMAGE RESULTING IN BROCA'S, OR MOTOR, APHASIA.

EXPRESSIVE REGION OFTEN THOUGHT TO INCLUDE MORE THAN BROCA'S AREA.



WERNICKE'S AREA (AREA 22)

RECEPTIVE (SENSORY) REGION OF COMMUNICATIVE LANGUAGE, COMPREHENSION OF SPEECH.

DAMAGE RESULTS IN WERNICKE'S, OR SENSORY, APHASIA.

CYTOARCHITECTURAL LOCUS LESS CONTROVERSIAL.

2. TOPOGRAPHICAL REPRESENTATION AND FUNCTIONAL ASPECTS OF BROCA'S (AREAS 44 + 45) AND WERNICKE'S (AREA 22) AREAS.

Broca's Area (Figure 2) has been typically represented as located in Area 44 and parts of adjacent Area 45. The ease with which it is distinguished varies considerably from brain to brain. Nevertheless Paul Broca first called attention to this region of the left frontal cortex after he had observed two patients with loss of ability to speak resulting from damage restricted to this area. Broca's Aphasia, a disturbance of the capacity to express language in a meaningful way in speech or writing, has persisted for over a century as one of the cornerstones of aphasiology.

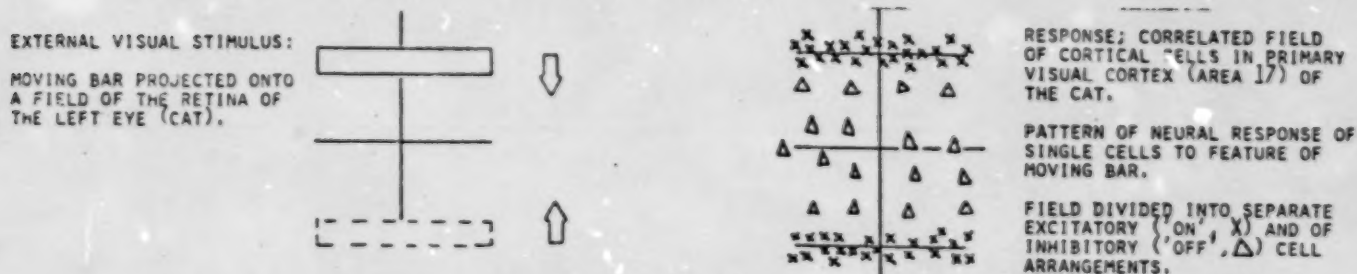
Wernicke's Area, known for almost as long, - the portion of Area 22 just behind Areas 41 and 42 - when destroyed has been shown to lead to an inability to comprehend the spoken word, and occasionally the written word and sign gestures. This combination of receptive language disorders is sometimes called Wernicke's Aphasia, or sensory aphasia.

While both Broca's and Wernicke's Areas have been reasonably well established within the "party line" as regions fundamentally underlying specific language abilities, there has been controversy for many years over the precise cortical and cellular arrangements and physiological function involved within these two areas - especially in regard to Broca's Area (Mohr, 1975). This region of cortical organization is now generally regarded to include more than Areas 44 and adjacent parts of Area 45, the extent of which depending upon whether it is thought of as no more than a region of skilled motor movements, or something more profound in the chain of articulated speech.

Controversy on Wernicke's Area has not focused so much upon anatomical questions, as on how to regard the physiological function of this area.

One of the difficulties that investigators have had in regard to the interpretation of Wernicke's Area stems from the problem that this locus has been regarded clinically in terms of a final word processing "center" or some such language imagined anthropomorphism. This is the same problem which literally plagued investigators in the study of primary visual cortex until recent years. Workers in this area could not easily banish the notion of visual images, as such. In Wernicke's Area, recent researchers such as Lenneberg (1974), and others, are probably more correct than the tradition of earlier investigators, in their resistance to the notion of "language spots." Lenneberg rejects outright the idea of word processing centers in any area of the cortex on the grounds that many parts of the brain must contribute to the function of behavior that is as inseparable from perception, memory and every other cognitive process, as is language. This is a favorable direction, but it has the result of explaining away the problem of how speech patterns might become acquired at all - against overwhelming evidence for some kind of language specialization lateralized in the human brain. We would favor a third alternative, the possibility that language centers do far less than at first thought, but are yet crucial in the neural coding pattern of language learning systems.

A clear parallel example of this is shown by research findings in primary visual cortex (Area 17). See Figure 3.



3. HUBEL AND WIESEL. RECEPTIVE FIELD OF SINGLE CELLS IN VISUAL CORTX TO FEATURE OF MOVING BAR (NUMEROUS SPECIFIC CELL PATTERNS ARE FOUND IN RESPONSE TO OTHER VISUAL FEATURES, E.G., CONTOURS, ANGLES, POSITION IN FIELD, ETC.).

Until the pioneering work of Hubel and Wiesel (1959; 1968) it was not understood what role this specialized primary region of neocortex played in the visual process. It has been known for sometime that primary visual cortex was not totally responsible for visual discrimination, however its exact role toward the production of vision remained elusive.

Since Hubel and Wiesel's demonstration in the cat, and later in the primate, we know that the visual cortex contains neurons which are specialized in their detection of specific features in the visual world: specific visual neural arrangements responding to specific external stimuli, such as, contours, angles, illuminated lines, lines in certain orientations. Some visual cells excite only if a certain line appears in a precise part of the visual field, other cells being indifferent to location. These detectors are part of the innate neural arrangement and physiological function of the visual cortex.

As investigators were quick to see it makes sense to assume that in the course of evolution neural systems have evolved for detecting elements and encoding information about visual input. It has become clear that the primary visual cortex possesses "wired in" detectors for the complex aspects of visual response to the environment.

Similarly, Lettvin (1959), Capranica (1965; 1966) and others, have found in inframammalian animals, such as the frog and bullfrog, evidence that certain aspects of coding properties are also found in peripheral neural systems. Lettvin and his collaborators, in their paper entitled, "What The Frog's Eye Tells The Frog's Brain," reported that, recording from single optic nerve fibers, the frog's retina performed four distinctive operations on a visual image. Groups of fibers were found which responded to edges (sustained contrast detectors) to the curvature of an object (net convexity detectors) to the movement of edges (moving edge detectors), and to a sudden reduction of illumination (net dimming detectors). These operations suggested to the authors, "much more the flavor of perception than of sensation," and with not much stretch of the imagination one might readily identify these response characteristics as "bug perceivers" (See Lettvin, et al., 1959, p. 1951). In similar studies, Capranica (1965; 1966), and Frishkopf, et al. (1968) reported aspects of coding properties of the auditory system used to detect vocalization in the bullfrog.

The question of phylogenetic parallels of language specialization is interesting in light of evidence of specific analyzers in primary visual cortex. Hubel and Wiesel's findings not only pertain to the anatomical and physiological arrangements in primary visual cortex in the cat and monkey, and presumably in the human, but also presumably to the specialization in the primary visual cortical representation across mammalian phylogeny as well.

Other sensory cortices have been studied with comparable questions in mind. Mountcastle (1957) and Mountcastle and Darian-Smith (1968) showed on the basis of microelectrode studies in primary sensory somatic cortex in the cat that successive neurons along the path of the electrode penetration are excited by the same stimulus at the body surface and are related to nearly identical body receptive fields. In line with this, Abels and Goldstein (1970) have found functional "columns" in the auditory cortex of the cat. Physiological

studies have in general given considerable credibility to the concept that the cerebral cortex is anatomically organized by cellular arrangements forming not only overlapping layers in the cortex (Lorente de No, 1949; Walsh and Ebner, 1970) but also functional vertical columns (Lorente de No, 1949; Woolsey and van der Loos, 1970; Peters and Walsh, 1972; Szentagothai and Arbib, 1975).

It is the lack of this kind of information regarding the work accomplished by human cortical regions in language related areas, perhaps especially Wernicke's Area, which precludes a basic knowledge of the processes of how language becomes acquired.

We ask, how does language get going, or best get going? How do we best arrange the evidence of clinical and experimental data in regard to the priorities of our sensory systems represented in the neocortex, in order to find clues to the most sensible methods for teaching language?

BROCA'S AREA

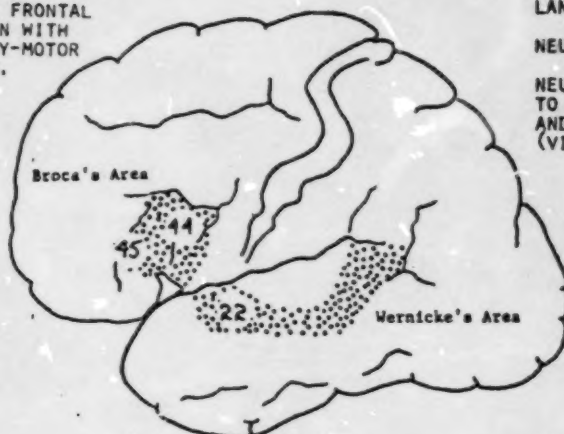
INTEGRATION OF FRONTAL
CORTICAL REGION WITH
SKILLED SENSORY-MOTOR
SOMATIC CORTIX.

WERNICKE'S AREA

FEATURE DETECTION OF
LANGUAGE ELEMENTS.

NEURAL ANALYZERS.

NEURAL ENCODING AVAILABLE
TO SENSORY AND INTEGRATIVE
AND MOTOR-EXPRESSION REGIONS,
(VISUAL, AND SOMATIC).



4. NEUROLINGUISTIC ASSUMPTIONS RELATED TO WERNICKE'S AND BROCA'S AREAS.

In the normal hearing individual (see Figure 4) it would appear simplest to assume that in response to environmental speech, feature detecting mechanisms are very likely to be involved in the encoding of human language, intrinsically specialized in the earliest organization of language development.

It is our leading perception that normal language acquisition is specifically organized within the nervous system through an encoding process, through some arrangement of neural analyzers specific to neocortical areas of speech in a way analogous to Hubel and Wiesel's evidence for feature detection specific to visual cortex. It does not appear evident that other cortical

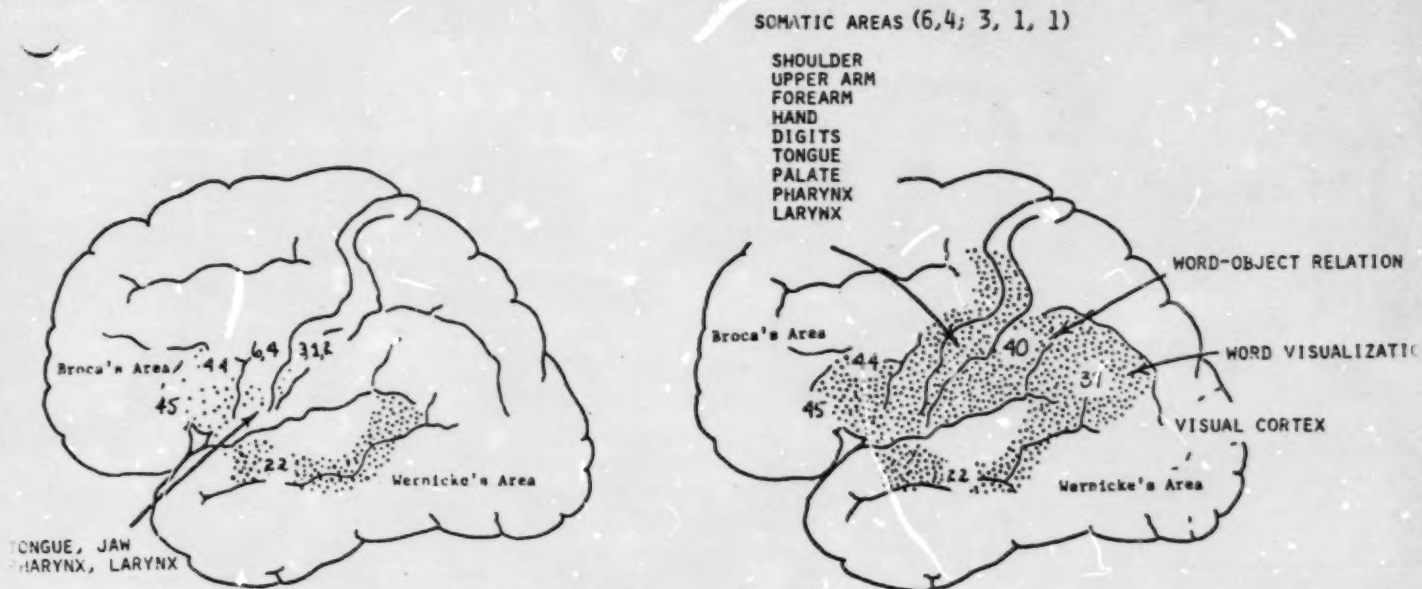
sensory and motor systems outside of specific language areas, such as visual, visual-motor mechanisms, somatic sensory-motor representation, are specialized in the primary intrinsic neural encoding in the development and functional maintenance of language.

This would lead us to assume that verbal receptor analyzers detect, or are excited by sounds in the environment which are universally specific to language ontogeny. The sounds of the falling tree excite no such system.

It is reasonable to assume a priority in importance of Wernicke's Area in language acquisition, stressing that this system may be innately receptive in the detection and analysis of the elements of language information occurring in the environment. The auditory nature of language, as opposed to those systems intrinsic to reading and writing, or patterning of speech habits, then becomes fundamental.

We could ask the question, what has to happen in the brain in order to learn a language - in any way we can understand that?

The first problem would be to describe those critical systems which are involved in language acquisition, and performance, and how the systems may be laid down in cortical development.



5. NEUROGENETIC PROGRESSION RELATED TO WERNICKE'S AREA, TO EARLY REGIONS OF EXPRESSION. LATER DEVELOPMENT OF SENSORY AND MOTOR AREAS TO LANGUAGE ACQUISITION. HIGHER CORTICAL PROCESSES, OF COGNITIVE AND INTELLECTUAL FUNCTIONS, BECOME ELABORATED DURING FIRST LANGUAGE ACQUISITION; TOWARD LANGUAGE ACQUISITION SYSTEMS AVAILABLE FOR A SECOND LANGUAGE.

The neocortex is to a large extent undeveloped at birth. As shown in Figure 5, the laying down of the neural systems subserving the vast range of cerebral hemisphere functions occurs gradually in man over a period of years; and it is possible that tissue mechanisms are never fully fixed. Piaget's observations and experiments indicate that the behavioral and cognitive structures comprising language, mature developmentally in children postnatally over years, and continually change as a consequence of the person's encounters with his environment. (Piaget, 1923, 1926). What we regard in psychology as cognitive development can be represented as the developing expression of an underlying maturation process. We are beginning to learn that the genetic unfolding of the capacities for language, and the multitude of neocortical specialized arrangements mediating sensory, motor and cognitive events, is being laid down in the first several years of life.

What is in fact "developmental" are those capacities that cannot be learned before a certain time, within a predetermined sequence of events. For example, on the left what is shown are areas most initially involved in language development. Namely, Wernicke's Area - suspected to be principally involved in the essential receptive and encoding capacity in communicative language - coupled with those systems involved in language expression, that is, Broca's Area in association with sensory-motor regions of the tongue and larynx, in Areas 4 and 6; 3, 1 and 2.

As shown on the right, it must be assumed that there is a neurogenetic progression in regard to Wernicke's Area to include neuroanatomical associations with visual and somatic information. This development then leading to modes of language expression including facial and limb musculature, fine motor learning, such as in the wrist, and a range of cognitive and intellectual skills. It is just this range of developed language system in the mature cortex which are now relatively sophisticated in their specialized synaptic arrangements and intra- and intercortical connections, which are available in the acquisition of a second language. In these latest stages of language maturation further well established sensory integrative mechanisms are now accessible. An example, would be Area 39 and 40, regions of the posterior parietal cortex - between visual cortex and Wernicke's Area.

Area 39 has been shown to be critical in visual-verbal functioning - in reading and in naming of objects. Geschwind (1967) has described a patient who through a lesion in Wernicke's Area, was able to compensate for his defect through a dependence upon this posterior cortex. The patient could name objects that he was able to use, and could match objects by touch. However, he was not able to name the objects when blindfolded. Relevant information, usually mediated through Wernicke's Area, it seemed could not reach speech areas. The development of the capacity for visual labeling, reading, and most likely the visualization of language is dependent upon this region.

It would appear that this area develops reciprocally with Wernicke's Area early in speech - as with primitive labeling - together with Area 40, important in word-object association. It is believed that the comprehension of visual words evokes an auditory pattern in Wernicke's Area through a neural sequence beginning with visual information via Area 39. Conversely, if a word is to be spelled, auditory information in some way connected with Wernicke's Area is passed on to Area 39 where the visual information can contribute to the evocation of a visual pattern.

In general, an understanding of how the developing cortex is related to language acquisition, leads us to see some of the possible differences - and similarities - in the cortical systems involved in first and second languages (see Table 6).

6. TABLE OF SIMILARITIES AND DIFFERENCES AMONG CORTICAL LOCI INCORPORATED INTO THE LEARNING OF L 1 AND L 2.

FIRST LANGUAGE ACQUISITION (L 1)

A. NOT INCLUDING READING AND WRITING (EARLY DEVELOPMENT):

LISTENING AND COMPREHENSION.

AREA 22, WERNICKE'S AREA.
VERBAL DETECTION AND ANALYSIS
OF ELEMENTS OF LANGUAGE.

SPEAKING.

AREAS 44 + 45, BROCA'S AREA.
FRONTAL REGION ASSOCIATED
WITH SOMATIC SENSORY-MOTOR
REGIONS OF LARYNX, PHARYNX,
PALATE, TONGUE, JAW.

AREA 40. WORD-OBJECT RELATION
TOWARD COGNITIVE AND INTELLECTUAL
PROCESSES.

AREA 39. EARLY WORD-OBJECT NAMING.

B. INCLUDING READING, WRITING AND GRAMMATICAL STRUCTURE:

AREA 22, WERNICKE'S AREA, WITH
ASSOCIATION OF VISUAL-AUDITORY
INFORMATION.

AREAS 44 + 45, BROCA'S AREA. ADDED
ASSOCIATION WITH CORTICAL SOMATIC
SENSORY-MOTOR REGIONS OF DIGITS, HAND,
FOREARM, UPPER ARM, SHOULDER.

AREA 40. WORD-OBJECT RELATIONSHIP
TOWARD COGNITIVE AND INTELLECTUAL
PROCESSES.

AREA 39. VISUAL NAMING OF OBJECTS AND
WORD-SYMBOL VISUALIZATION AND
VISUALIZATION OF WORD COMPLEXES.

SECOND LANGUAGE ACQUISITION (L 2)

A. NOT INCLUDING READING AND WRITING:

LISTENING AND COMPREHENSION.

AREA 22, WERNICKE'S AREA.
VERBAL DETECTION AND ANALYSIS
OF ELEMENTS OF LANGUAGE.

SPEAKING.

AREAS 44 + 45, BROCA'S AREA.
FRONTAL REGION ASSOCIATED
WITH SOMATIC SENSORY-MOTOR
REGIONS OF LARYNX, PHARYNX,
PALATE, TONGUE, JAW.

AREA 40. WORD-OBJECT RELATION
TOWARD COGNITIVE AND INTELLECTUAL
PROCESSES.

AREA 39. WORD-OBJECT NAMING.

B. INCLUDING READING, WRITING AND GRAMMATICAL STRUCTURE:

AREA 22, WERNICKE'S AREA, WITH
ASSOCIATION OF VISUAL-AUDITORY
INFORMATION.

AREAS 44 + 45, BROCA'S AREA. ADDED
ASSOCIATION WITH CORTICAL SOMATIC
SENSORY-MOTOR REGIONS OF DIGITS, HAND,
FOREARM, UPPER ARM, SHOULDER.

AREA 40. WORD-OBJECT RELATIONSHIP
TOWARD COGNITIVE AND INTELLECTUAL
PROCESSES.

AREA 39. VISUAL NAMING OF OBJECTS AND
WORD-SYMBOL VISUALIZATION AND
VISUALIZATION OF WORD COMPLEXES.

**C. NOT INCLUDING LISTENING AND SPEAKING:
INCLUDING READING, WRITING AND GRAMMATICAL
STRUCTURE:**

AREA 39. VISUAL NAMING OF OBJECTS.
VISUALIZATION OF SYMBOLS, WORDS AND
WORD COMPLEXES.

AREA 40. VISUAL WORD-OBJECT RELATION. WITH
COGNITIVE AND INTELLECTUAL PROCESSES.

AREAS 44 + 45, BROCA'S AREA IN ASSOCIATION
WITH SOMATIC SENSORY-MOTOR REGIONS OF
DIGITS, HAND, FOREARM, UPPER ARM, SHOULDER
IN REGIONS 4, 6, 3, 1, 2.

The learning of a second language involving listening, speaking, reading, writing, and grammatical structure, would seem to have in common with the learning of L 1 the functioning of Wernicke's Area, in the receptive encoding of specific auditory elements of the language, and the function of Broca's Area related to peripheral speech mechanisms in the somatic sensory-motor cortical regions. Also interrelated with Wernicke's Area and expressive cortical regions, are regions related to visual and verbal interaction, mediated by Areas 39 and 40.

While the underlying aspects of learning speech in a second language appear to have a great deal in common with the organization of speech in L 1, we can also see that learning to read and write in L 1 appears to have parallel demands with the more formal requirements in L 2 - both have in common the typical cognitive demands of the classroom. The function of Areas 39 and 40 involves more than the previous auditory-visual & associative naming of objects, but now becomes incorporated with further cognitive and intellectual abilities - converging into complex events involving symbol and thought.

Thus we have a situation where the learning of L 1 and L 2 when restricted to speech, follows the same neurolinguistic pathways, aided more rapidly by cognitive strategies when learned as a second language. When L 2 is restricted to the learning of reading, writing and grammatical structure, unaided by the foundation of speech, it is, or can only be, a second language (a dead language), dependent upon an array of cognitive and intellectual skills, unsupported by the specific specialized neural arrangements in Wernicke's Area.

METHOD

CHOOSING CONTRASTING PICTURES
WITH PRESENTED AUDITORY WORDS
AND SENTENCES.

NO SPEAKING OR WRITING
UNTIL VOCABULARY AND
GRAMMAR ARE LEARNED.

FOLLOWS SENSORY PATTERN
OF NATIVE LEARNED SPEECH.



CORTICAL AREAS

AREA 22, WERNICKE'S AREA.
VERBAL DETECTION AND
ANALYSIS OF ELEMENTS OF
LANGUAGE.

AREA 39. VISUALIZATION OF
LANGUAGE, IN ASSOCIATION
WITH WERNICKE'S AREA.

AREA 40. WORD-OBJECT RELATION
TOWARD COGNITIVE AND INTELLECTUAL
PROCESSES.

7. WINITZ AND REEDS, "RAPID ACQUISITION OF A FOREIGN LANGUAGE
BY THE AVOIDANCE OF SPEAKING."

It becomes clear that different strategies for teaching foreign languages can exercise widely differing neurolinguistic pathways according to the structure of the method. This can be illustrated with three examples. The first is presented in Figure 7.

Very briefly, what is shown is a cortical representation of language related areas assumed to be principally involved in the Winitz and Reed's method: "Rapid Acquisition of a Foreign Language by the Avoidance of Speaking" (1973). This approach which appears to be essentially sensory depends upon the areas of Wernicke and posterior parietal regions 39 and 40 (i.e., visual-auditory association, and word object relations). In this method the learner must choose one picture in a quadrant which corresponds to the meaning of a spoken presented word, or sentence. The technique appears to succeed in teaching vocabulary and grammatical structure at a much faster rate than usual. After basic grammar and vocabulary are well learned, and students have a good sense of word-object relations, talking may start - being apparently more effortless and accessible to learning. By postponing pronunciation for so long, the authors claim that the result is much more like the acquisition of native speech. It is our view that the emphasis of this method may be on the detection and analysis of verbal auditory elements within Wernicke's Area, than associated with other sensory and cognitive integrating mechanisms, and passed on to the modalities of expression.

To restate what Winitz and Reed suggest: in their method there is an innate progression of neurolinguistic events in the early stages of learning a second language which is likely to pertain to the learning of the first.

METHOD

AUDIO-LINGUAL PATTERN
DRILL OF MIMICING AND
MEMORIZING WORDS AND
SENTENCES.

EMPIRICIST-BEHAVIORIST
LEARNING THEORY. ASSUMES
LANGUAGE AS SPEECH HABITS.

NO EMPHASIS PLACED ON
WORD-OBJECT ASSOCIATION
TOWARD COGNITIVE AND
INTELLECTUAL PROCESSES.

6,4; 3,1,2.
LARYNX, PHARYNX,
PALATE, TONGUE,
AND JAW



CORTICAL AREAS

AREA 22, WERNICKE'S AREA.
VERBAL DETECTION AND
ANALYSIS OF ELEMENTS OF
LANGUAGE.

AREAS 44 + 45, BROCA'S AREA.
ASSOCIATED WITH SOMATIC
SENSORY-MOTOR REGIONS.

AREAS 6, 4; 3,1,2.
SOMATIC SENSORY-MOTOR
REGIONS OF LARYNX, PHARYNX,
PALATE, TONGUE AND JAW.

8. MIMICRY, MEMORIZATION, AND PATTERN DRILL - EXTREME FORM.

In another example: the method of Mimicry, Memorization and Pattern Drill - Extreme Form, (Figure 8) language acquisition is shown to occur in the immediate linking up of Wernicke's Area with motor expressive mechanisms associated with Broca's Region. No visual information is involved. Connections with Areas 40 and 39 are not very much involved unless modifications in the method are made by the program or instructor. There is a preponderance of mechanical drill and little practice in the comprehension of language meaning.

METHOD

AUDITORY-VISUAL INFORMATION
EMPHASIZING WORD-OBJECT RELATION
TOWARD COGNITIVE AND INTELLECTUAL
PROCESSES.

VERBAL COMPREHENSION COMBINED
WITH VERBAL EXPRESSION.

COMPREHENSION OF WRITTEN
(VISUAL-AUDITORY) WORDS AND
SENTENCES INTEGRATED WITH SKILLED
SOMATIC SENSORY-MOTOR REGIONS.

FOLLOWS NEUROGENETIC PROGRESSION
INCREASED BY COGNITIVE AND
INTELLECTUAL SKILLS. INDIVIDUAL
DIFFERENCES SEEN WITHIN PROGRESSION.



CORTICAL AREAS

AREA 22, WERNICKE'S AREA.
VERBAL DETECTION AND
ANALYSIS OF ELEMENTS OF
LANGUAGE.

AREA 40. WORD-OBJECT RELATION
TOWARD COGNITIVE AND INTELLECTUAL
PROCESSES.

AREAS 44 + 45, BROCA'S AREA.
ASSOCIATED WITH SOMATIC
SENSORY-MOTOR REGIONS.

AREAS 6, 4; 3, 1, 2. SOMATIC
SENSORY-MOTOR REGIONS OF
THE LARYNX, PHARYNX,
PALATE, TONGUE, DIGITS,
HAND, FOREARM, UPPER ARM,
SHOULDER.

AREA 39. VISUALIZATION OF
LANGUAGE IN ASSOCIATION
WITH WERNICKE'S AREA.

2. DIRECT METHOD OF DE SAUZÉ ("MULTIPLE APPROACH"; "NATURAL METHOD")

Our final example (Figure 9) is the Direct Method of de Saüzé (1929) more sophisticated and well balanced than the well known Direct Method of the Berlitz School. (See Diller 1971, Chapter 7). de Saüzé used the term "Multiple Approach" not only because he emphasized all four language modes from the beginning - listening, speaking, reading and writing - but also because he integrated into his method the conscious understanding of grammatical structure and meaningful practice wherein the word-meaning relationship is of primary importance. The emphasis on listening, speaking, reading and writing then, is not so much on the four "skills," as in audio-lingual methodology but a means for improving the student's comprehension and mastery of word object relations in association with cognitive and intellectual processes.

There are obvious conclusions to be drawn from such a neurolinguistic analysis of language teaching methods. These three methods have in common a presumed reliance on Wernicke's Area for detecting and analyzing the sounds of spoken language. Wernicke's Area, in fact, must be involved with all successful methods of foreign language teaching, as it is central both to the processing of the sound-meaning relationship and to the transfer of sound to speech. As perhaps inferable in auditory language, from Hubel and Wiesel's studies of vision, a set of neural receptors and analyzers may well deal with the fundamental features of phonology and semantics.

Methods of language teaching differ, however, in the way in which they conjoin Wernicke Area mechanisms with other language processing areas in the brain, and thus with how much functional information of Wernicke's Area is integrated into their use. The schematic drawings of language areas most clearly involved with each method cannot give us a numerical score on which one method is easily ranked against another. It is our judgment that Winitz and Reeds have a method which would be very attractive to certain types of students in spite of the neglect (or long postponement) of the expression of speech (Broca's and related areas).

Mim-Mem and Pattern Drill, by emphasizing the mechanisms of Broca's and related motor areas, produces students who very quickly attain varying high levels of pronunciation. Pronunciation can be empty, however. The method makes, perhaps, a serious error in not putting more emphasis on the sound-meaning relationship. The early proponents of this method assumed that the concrete sounds of speech were much more closely related to large elements of meaning than seems possible now, given the seemingly very fundamental functions of Wernicke's Area.

The Direct Method-Multiple Approach of de Saüzé may build up an understanding of words and grammatical structure somewhat more slowly than the method of Winitz and Reeds, because it attempts a continuously varying but simultaneous integration of all language areas. With interaction and practice however, we judge that it will turn out to be the better option (see Diller 1971; 1975, for discussion of other considerations). This method would seem to be especially appropriate for classes where individual differences are important to acknowledge.

While the gaps between our present-day understanding of the nervous system and its relationship to applied linguistics are great, it seems clear that very different neural pathways and mechanisms are employed by students using different methods of language teaching.

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